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AGRICULTURAL MEMORANDUM NO 628

A METHOD FOR ESTIMATING WORK DAYS FOR GRASS CONSERVATION USING ACCUMULATED VAPOUR PRESSURE DEFICITS

by F P Sims

INTRODUCTION

Analyses of suitable weather for grass conservation have mainly been based on sequences of dry days ie days without measurable rain. For haymaking by traditional methods a spell of 5 consecutive dry days has been taken as the minimum period necessary to dry the crop. The acknowledged drawback to this method is that some of the "dry days" will in fact be too humid for much drying to take place, while on some of the days excluded because of rain there will have only been a few showers with good drying conditions in between. These 2 factors are generally regarded as cancelling each other out, but it is by no means certain that this is the case. Furthermore the length of time required to dry grass varies, being greatest early in the season when the young grass has a higher initial moisture content.

To obtain the highest quality hay (or silage) in respect of digestibility and protein content, grass should be cut at an optimum date which depends on the variety of grass and the weather during the growing season. There is a growing body of opinion that cutting should take place around this date even if weather conditions are likely to delay further field work, since quality deteriorates thereafter more rapidly in the standing crop than in the cut grass. Admittedly serious loss of quality will occur in a hay crop if protracted bad weather ensues, but this is little more than the normal hazard of haymaking.

An attempt has therefore been made to assess the periods of time required to dry grass to any required moisture content, assuming cutting to take place on each successive day throughout the season. Although the method is applicable to any form of grass conservation, this memo will be confined to the case of field-dried hay mown by conventional cutter-bar or rotary mowers ie without any deliberate attempt at "conditioning".

CHOICE OF PARAMETERS

Spatz et al (1970) found significant correlations between the drying rate of grass and each of 3 meteorological parameters, accumulated vapour pressure deficit, sunshine hours and solar radiation. The highest correlation was with accumulated vapour pressure deficit, and this was the variable on which their results are based. Brown and Charlick (1972) describe a similar approach used in work at NIAE on mowers and mower-conditioners.

The method described here has therefore been based on data from these 2 sources, using accumulated vapour pressure deficit as a measure of the drying potential of the atmosphere.

EFFECTS OF DEW AND RAINFALL

Both Spatz and NIAE used only daytime values of vapour pressure in calculating the daily deficit, the night period being excluded because of dew. Substantial deficits do however occur on some nights, particularly windy ones, so the following scheme has

been adopted:

Daytime - saturation deficits used in full

Nightime - deficits in excess of 1 mb used

In the work already quoted only spells of dry weather were considered. However from figures given for the increase in moisture content of cut grass due to rain it is possible to deduce an average value such that each millimetre of rain falling on the cut crop increases the total drying requirement by 4 mb-hours of accumulated vapour pressure deficit.

DRYING CRITERIA

The accumulation of vapour pressure deficit required for grass drying varies with date of cutting, because of the higher initial moisture content of grass cut early in the season. The requirement also depends on a number of other factors eg variety of grass, fertilizer treatment, weather conditions during the growing season, post-cutting treatment etc. The Spatz and NIAE results show considerable variations, but the criteria given in Table 1 can be taken to represent average conditions, assuming that the operations of turning or tedding were carried out promptly when required.

TABLE 1. ACCUMULATED VAPOUR PRESSURE DEFICIT REQUIRED TO DRY HAY TO 25% MOISTURE CONTENT (WET BASIS)

CUTTING DATES	ACC VPD IN MB-HOURS
May 15-24	440
May 4-June 3	410
June 4-13	380
June 14-23	360
June 24-July 3	350
July 4-13	340
July 14 onwards	330

METHOD

For each successive period of 24 hours starting in the morning accumulated vapour pressure deficits are calculated, using saturation deficits for daylight hours and deficits in excess of 1 mb for the night period. Using 3-hourly observations, readings at 0900 to 1800 inclusive are regarded as daytime and 2100 to 0600 as night time, each reading being multiplied by 3 to obtain the total in mb-hours.

From the daily total thus obtained, 4 mb-hours is subtracted for each millimetre of rain in the preceding 24 hours (ie up to 0900 hours). Negative values resulting from this subtraction are allowed to stand.

Each day throughout the period is then considered successively, and the daily accumulations (adjusted for rain as above) are added forward algebraically until the required total for the date of cutting is reached. Adding one day to the number of days required to reach the total gives the number of working days required to make hay.

DISCUSSION OF RESULTS

Table 2 shows the results obtained for Shawbury for succeeding 10-day periods from 15 May to 12 August based on 3-hourly observations and averaged over the 10 years 1961 to 1970.

TABLE 2. SHAWBURY 1961-70. Average number of occasions to make hay in a given number of days assuming cutting on each successive day of 10-day periods shown.

NO OF DAYS REQUIRED TO MAKE HAY

	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
May 15-24		0.3	0.3	0.6	1.5	1.8	0.7	1.9	0.4	0.5	0.6	0.4	0.3	0.6	0.1
May 25-June 3		0.3	1.7	2.5	1.6	0.9	1.4	0.9	0.2	0.3	0.1	0.1			
June 4-13	0.4	1.8	2.0	2.0	2.1	0.7	0.6	0.0	0.0	0.2	0.2				
June 14-23		0.7	2.1	2.4	1.4	1.5	0.8	0.4	0.1	0.3	0.1	0.2			
June 24-July 3	0.1	0.4	3.3	2.1	1.5	1.0	0.2	0.4	0.7	0.2	0.1				
July 4-13		1.6	2.3	0.6	1.5	1.3	0.8	0.5	0.6	0.4	0.2	0.0	0.1	0.1	
July 14-23	0.2	0.7	2.0	2.6	2.5	0.9	0.5	0.0	0.2	0.1	0.3				
July 24-Aug 2	0.3	0.6	1.5	2.9	2.8	0.8	0.5	0.4	0.2						
Aug 3-12	0.2	0.9	0.9	1.3	3.3	1.7	1.2	0.3	0.2						

From Table 2 values for the conventional period for first-cut hay, 23 May to 3 July were extracted and combined to give the curve shown in Figure 1. Very little smoothing was required to produce this curve, and from it we can infer that the results are not unreasonable. Experience tells us that most hay takes at least 5 days in the making, although in the very best drying weather it can be made in as little as 3 days. On the other hand had the maximum of the curve been displaced much to the right then haymaking in North Salop would be considerably less successful than it actually is.

Undoubtedly some of the longer weather sequences included in Table 2 would result in poor hay. However if weather conditions permit hay to be made in 5 days or less it is fairly safe to assume that loss of quality due to weathering would be acceptably small. The sums of the entries in the first 3 columns of Table 2 (3 to 5 days) can therefore be regarded as representing "good haymaking weather", and be used as the basis of comparison with other methods or locations.

THE METHOD ON TEST

At a farm about 10 miles to the West of Shawbury grass was cut for hay on 5 June 1974 using a drum mower, and was observed by the writer on the following day and again a week later. Table 3 shows the vapour pressure deficit method as applied to this cutting date, using actual observations from Shawbury.

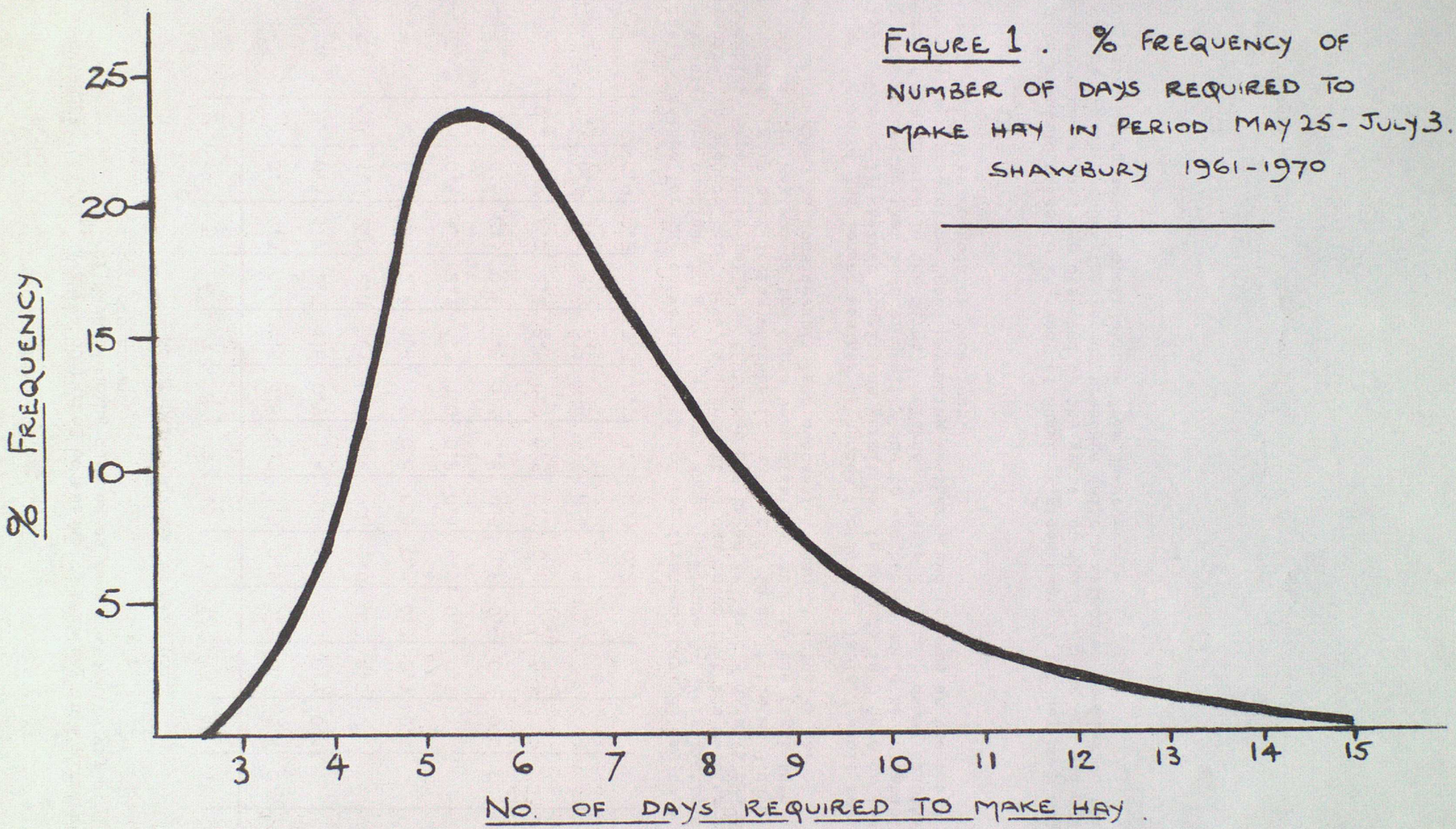

FIGURE 1. % FREQUENCY OF NUMBER OF DAYS REQUIRED TO MAKE HAY IN PERIOD MAY 25 - JULY 3. SHAWBURY 1961-1970

TABLE 3. Accumulation of vapour pressure deficits at Shawbury with adjustments for rainfall. Commencing am 5 June 1974.

	Daily deficit mb-hour	Rainfall previous 24 hours (mm)	Adjusted deficit	Running total
5 June	52	Nil	52	52
6 June	44	5	24	76
7 June	91	4	75	151
8 June	55	5	35	186
9 June	62	Trace	62	248
10 June	56	5	36	284
11 June	70	1	66	350
12 June	47	Trace	47	397
13 June	141	Trace		

The criterion for the cutting date (380) was therefore reached on 12 June, giving a theoretical 8 + 1 = 9 working days to make hay. In fact on the ninth day (13 June) after being tedded twice, the hay, judged to be of fair quality though not a heavy crop, was ready for baling by the late afternoon. It should be noted that during this period 20 mm of rain was recorded at Shawbury, and the only consecutive dry days were the 11, 12 and 13 June.

COMPARISON WITH DRY SPELL METHOD

Table 4 gives a comparison between the average number of occasions when hay could have been made in 5 days or less at Shawbury and the average number of 5-day dry spells over the same period of 10 years, 1961 to 1970.

TABLE 4. SHAWBURY Averages 1961-1970

	Occasions to Make Hay in 5 Days or Less	5-Day Dry Spells
May 15-24	0.6	1.2
May 25-June 3	2.0	4.1
June 4-13	4.2	3.0
June 14-23	2.8	1.7
June 24-July 3	3.8	2.7
July 4-13	3.9	0.9
July 14-23	2.9	1.9
July 24-Aug 2	2.4	1.3
Aug 3-12	2.0	0.5

This suggests that for Shawbury the dry spell method gives an over-estimate of the haymaking potential early in the season but proceeds to an increasing under-estimate as the season goes on.

CONCLUSION

It is thought that the method as described gives a fairly realistic estimate of the prospects for grass conservation, and certainly goes some way to answering the criticisms of farmers and others, particularly in the Western counties, concerning our failure to include humidity in the calculations.

The use of appropriate criteria for the drying requirement permits the study of various methods of grass conservation, and it is hoped to provide comparisons of the available work-days for different methods and locations. Although a Wang computer programme has been written to perform some of the calculations, the assembly of the data is rather a lengthy process and ways are being sought of reducing the labour.

REFERENCES

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Any comments or suggestions on this paper should be sent to the author.

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